

Claims

1. A fuel injection valve for internal combustion engines, having an outer valve needle (15), which by means of a longitudinal motion cooperates with a valve seat (20) for opening and closing at least one outer injection opening (22), and having an inner valve needle (17), which is disposed in the outer valve needle (20) and which by means of its longitudinal motion cooperates with a valve seat (20) for opening and closing at least one inner injection opening (24), and having a control chamber (28), which can be filled with fuel under pressure, the fuel pressure acting on the outer valve needle (15) and the inner valve needle (17) in such a way that as a result, a closing force in the direction of the valve seat (20) is exerted on the inner valve needle (17) and the outer valve needle (15), and having an inflow chamber (12), which at least partly surrounds the outer valve needle (15) and can be filled with fuel under pressure, characterized in that by means of the fuel pressure in the inflow chamber (12), an opening force oriented counter to the closing force acts on both the inner valve needle (17) and the outer valve needle (15).
2. The fuel injection valve as defined by claim 1, characterized in that between the outer valve needle (15) and the inner valve needle (17), an intermediate chamber (50) is embodied, which is always in hydraulic communication with the inflow chamber (12).
3. The fuel injection valve as defined by claim 2, characterized in that an inner pressure face (48), which is subjected to the pressure in the intermediate chamber (50), is embodied on the inner valve needle (17).

4. The fuel injection valve as defined by claim 2, characterized in that the communication of the intermediate chamber (50) with the inflow chamber (12) is established via at least one connecting bore (38) embodied in the outer valve needle (15).
5. The fuel injection valve as defined by claim 1, characterized in that on the inside of the outer valve needle (15), a shoulder (47) is embodied, which is located opposite the inner pressure face (48) of the inner valve needle (17), and which upon contact of the inner valve needle (17) and the outer valve needle (15) with the valve seat (20) is axially spaced apart from the inner pressure face (48).
6. The fuel injection valve as defined by claim 5, characterized in that the inner valve needle (17), after lifting from the valve seat (20) and after executing an opening stroke (h_i), comes with its face end (56) into contact with a fixed stop, and likewise the outer valve needle (17) after executing an opening stroke (h_a) comes with its face end (58) into contact with a fixed stop, and the opening strokes are dimensioned relative to one another such that the shoulder (47) of the outer valve needle (15) remains spaced apart from the inner pressure shoulder (48) when the outer valve needle (15) and the inner valve needle (17) are in their opening position.
7. The fuel injection valve as defined by claim 5, characterized in that the inner valve needle (17), after lifting from the valve seat (20) and after executing an opening stroke (h_i), moves into an opening position, and the inner valve needle (17), with its face end, comes into contact with a fixed stop, and the outer valve needle (15), in its opening stroke (h_a), comes with the shoulder (47) into contact with the inner pressure face (48).

8. The fuel injection valve as defined by claim 5, 6 or 7, characterized in that the inner valve needle (17), in its closing motion toward the valve seat (20), moves the opened outer valve needle (15) in the closing direction by means of contact with the shoulder (47).
9. The fuel injection valve as defined by claim 6 or 7, characterized in that the inflow chamber can be filled with fuel under pressure via an inflow throttle (34), and the inner valve needle (17) closes the inflow throttle (34) upon contact with the fixed stop.
10. The fuel injection valve as defined by claim 5, characterized in that the inner pressure face (48) and the shoulder (47) are embodied conically, and the conical faces have different opening angles, so that the shoulder (47) can come into contact with a sealing edge (51) on the inner pressure face (48) in such a way that the communication of the inflow chamber (12) with the intermediate chamber (50) via the connecting bore (38) is disrupted.
11. The fuel injection valve as defined by claim 1, characterized in that the valve seat (20) is embodied substantially conically, and at least one outer injection opening (22) and one inner injection opening (24) originate at the valve seat (20), and the outer valve needle (15) controls the outer injection openings (22), and the inner valve needle (17) controls the inner injection openings (24).
12. The fuel injection valve as defined by claim 11, characterized in that the outer valve sealing face (18) on the outer valve needle (15) is shaped such that upon contact of the outer valve needle (15) with the valve seat (20), the outer injection openings (22) are sealed off both upstream and downstream.

13. The fuel injection valve as defined by claim 12, characterized in that the outer valve sealing face (18) on the outer valve needle (15) has an outer sealing edge (25) and an inner sealing edge (27), of which the outer sealing edge (25) comes into contact with the valve seat (20) upstream of the outer injection openings (22) and the inner sealing edge (27) comes into contact with the valve seat (20) downstream of the outer injection openings (22), and in the process seal off the outer injection openings (22) in both flow directions.

14. The fuel injection valve as defined by claim 1, characterized in that the control chamber (28) communicates with an inflow conduit (9) via an inflow throttle (34) and via an outflow conduit (36) with a fuel tank (42), and a control valve (40) is disposed in the outflow conduit (36) and opens or closes (2/2-way valve) the outflow conduit (36).

15. The fuel injection valve as defined by claim 1, characterized in that the control chamber (28) can be made to communicate with a fuel tank (42) via an outflow conduit (36), and the outflow conduit (36), the fuel tank (42), and the inflow conduit (9) communicate with a control valve (40') in such a way that the outflow conduit (36) communicates with the fuel tank (42) in a first switching position of the control valve (40') and with the inflow conduit (9) in a second switching position (3/2-way valve).

16. The fuel injection valve as defined by claim 1, characterized in that a cylindrical extension (44) and a further cylindrical extension (39) are embodied on the inner valve needle (17) and are axially spaced apart from one another and are embodied such that at the cylindrical extensions (39; 44), a hydraulic sealing is effected place between the inner valve needle (17) and the outer valve needle (15), and by means of the hydraulic extensions (39;

42), a control volume (53) is defined which communicates with the inflow chamber (12) via a throttle bore (37).

17. The fuel injection valve as defined by claim 16, characterized in that the control volume (53) and the throttle bore (37) are designed such that the outer valve needle (15), at the maximum injection quantity of the fuel injection valve, does not come into contact with a fixed stop (ballistic mode of operation).

18. The fuel injection valve as defined by claim 17, characterized in that the closing speeds of the outer valve needle (15) and inner valve needle (17) are adapted to one another such that at the maximum injection quantity of the fuel injection valve, upon their closing motion, they come into contact with the valve seat (20) simultaneously.